

A review of *Gemixystus* Iredale, 1929 (Gastropoda: Muricidae) from Australia and New Zealand

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ABSTRACT. *Gemixystus* Iredale, 1929 is revised and *Apixystus* Iredale, 1929 is treated as a synonym. Sixteen species are reviewed: *G. fimbriatus* n.sp. (Recent: New South Wales, South Australia and Tasmania); *G. laminatus* (Petterd, 1884) (Recent: S Queensland to Tasmania), *G. leptos* (Houart, 1995) (Recent: S Queensland and Chesterfield Reefs), *G. polyphillius* (Tenison-Woods, 1879) (Recent: New South Wales and S Tasmania; fossil: Miocene, Victoria), *G. recurvatus* (Verco, 1909) (Recent: New South Wales and South Australia); *G. rhodanos* n.sp. (Recent: S Queensland to Tasmania), *G. rippingalei* (Houart, 1998) (Recent: Queensland), *G. stimuleus* (Hedley, 1908) (Recent: S Queensland and New South Wales), *G. apipagodus* (Ponder, 1972) (Upper Eocene: Oamaru, New Zealand), *G. comes* (Maxwell, 1992) (Eocene, New Zealand); *G. hypsellus* (Tate, 1888) (Eocene: Adelaide Bore, Australia), *G. icosiphyllus* (Tate, 1888) (Eocene: Adelaide Bore, Australia), *G. protocarinatus* (Laws, 1941) (Early Miocene: Pakaurangi Point, New Zealand), *G. zebra* n. sp. (Early and Middle Miocene: New Zealand) and two still unidentified fossil species from New Zealand.

All the identified species are described and illustrated, and their distribution is shown on a map. Three new species are described.

Lectotypes are designated for *G. hypsellus* (Tate, 1888) and *G. icosiphyllus* (Tate, 1888).

INTRODUCTION

Iredale (1929: 185-186) introduced several new generic and subgeneric names for muricid gastropods: *Xenotrophon*, *Enixotrophon*, *Emozamia*, *Enatimene*, *Litozamia*, *Gemixystus*, *Apixystus*, *Benthoxystus*, *Ollaphon* and *Anatrophon*, all of which were accompanied by few comments on shell morphology. *Emozamia* (type species: *Murex licinus* Hedley & Petterd, 1906) is now known to belong in Coralliophilinae (Kosuge & Suzuki, 1985) while *Ollaphon* (type species: *Trophon molorthus* Hedley & May, 1908) seems more likely to belong to Fascioliidae. All the other taxa are considered to be Muricidae, more precisely Trophoninae by recent authors (Radwin & D'Attilio, 1976; Vaught, 1989; Wilson, 1994). Iredale (1929: 185) separated *Gemixystus* from subgenus *Apixystus* because of their different protoconch morphology, *Gemixystus* having an "angulate apex" compared to the "smooth rounded apex" of *Apixystus*. However, such differences in Muricidae are now considered to be a useful tool at the specific level only.

The methodology used here was proposed and used by Merle (1999, 2001), and thereafter by Houart (2000, 2001), Merle et al (2001), and Merle & Houart (2003). This method mainly takes into

account the morphology of the spiral cords and of the apertural denticles of the outer lip. The identity of these characters is expressed by their topological and ontogenetical correspondences, codified in a terminology (see text conventions). Other important characters were also detected in the morphology of the protoconch.

Since Trophoninae are now considered to be polyphyletic (Kool, 1993a, 1993b), the type species, *Trophon geversianus* (Pallas, 1774) having been proved to be more akin to *Nucella* Röding, 1798 (Ocenebrinae), all these taxa, and many others, should be classified elsewhere. However, this may be done only after a careful and thoroughly study of all the taxa once considered as Trophoninae.

Abbreviations

AMS: The Australian Museum, Sydney.

IGNS (GS). Institute of Geological and Nuclear Sciences, Lower Hutt.

MNHN: Muséum national d'Histoire naturelle, Paris.

NMNZ: Museum of New Zealand Te Papa Tongarewa, Wellington.

SAM: South Australian Museum, Adelaide.

DW: Drague Warén (Warén dredge).

CP: Chalut à perche (Beam trawl).

Text conventions (see Figs. 1-5)

IP	Infrasutural primary cord (primary cord on shoulder)
adis	Adapical infrasutural secondary cord (shoulder)
P1	Shoulder cord
P2-P6	Primary cords of the convex part of the teleoconch whorl
s	Secondary cord of the convex part of the teleoconch whorl
s1: secondary cord between P1 and P2; s2: secondary cord between P2 and P3, etc.	
APERTURE	
D1-D5	Apertural denticles
SIPHONAL CANAL	
ADP	Adapical siphonal cord
MP	Median siphonal cord
ABP	Abapical siphonal cord

The terminology is occasionally put between brackets, this means that the character was observed in a few cases but not in all the specimens.

SYSTEMATICS

Family MURICIDAE Rafinesque, 1815
Gemixystus Iredale, 1929: 185.
Type species, by original designation: *Trophon laminatus* Petterd, 1884, Recent, Southeastern Australia.
= *Apixystus* Iredale, 1929: 185.
Type species, by original designation: *Trophon stimuleus* Hedley, 1907, Recent, Eastern Australia.
New synonymy.

Diagnosis. Shell: small, 3.5-7.2 mm in length. Last teleoconch whorl broad, large (60-74 % of total shell length), with 9-24 frilled or waved axial lamellae, and 3-9 rounded primary spiral cords. Aperture rounded or roundly-ovate, rarely ovate. Columellar lip smooth. Siphonal canal short, 9-23 % of total shell length. **Radula:** rachidian tooth with long, narrow, central cusp, short lateral denticles, long lateral cusps, and broad marginal cusps. Marginal area smooth or weakly folded. Lateral teeth sickle shaped, slender. **Operculum** not yet seen.

Remarks. Species of *Xymene* Iredale, 1915 and *Xymenella* Finlay, 1927 both differ from *Gemixystus* in having rounded axial ribs which intersect the spiral cords, giving the shell a nodose appearance rather than axial lamellae as in *Gemixystus*. The type species of *Terefundus* Finlay, 1927 (Fig. 36) differs in having a very small shell (usually a height less

than 5 mm in adult stage), a narrow columellar lip, completely adherent to the shell, a smooth aperture, and a smooth siphonal canal.
Of the two South African species referred to *Apixystus* (Houart, 1987), *A. kilburni* (off Rame Head, Transkei, southern Africa) is more closely related to *Pazinotus* Vokes, 1975 than to *Gemixystus* while *A. transkeiensis* (off Nthlonyane, Transkei, southern Africa) is here refered to *Vaughtia* Houart, 1995 (Ocenebrinae).

I. RECENT TAXA

Gemixystus finbriatus n.sp.
Table 1, Figs. 8, 20, 24-25

Type locality. Tasmania, E of D'Entrecasteaux Channel, 44°2.2' S, 146°50.5' E, 176 m

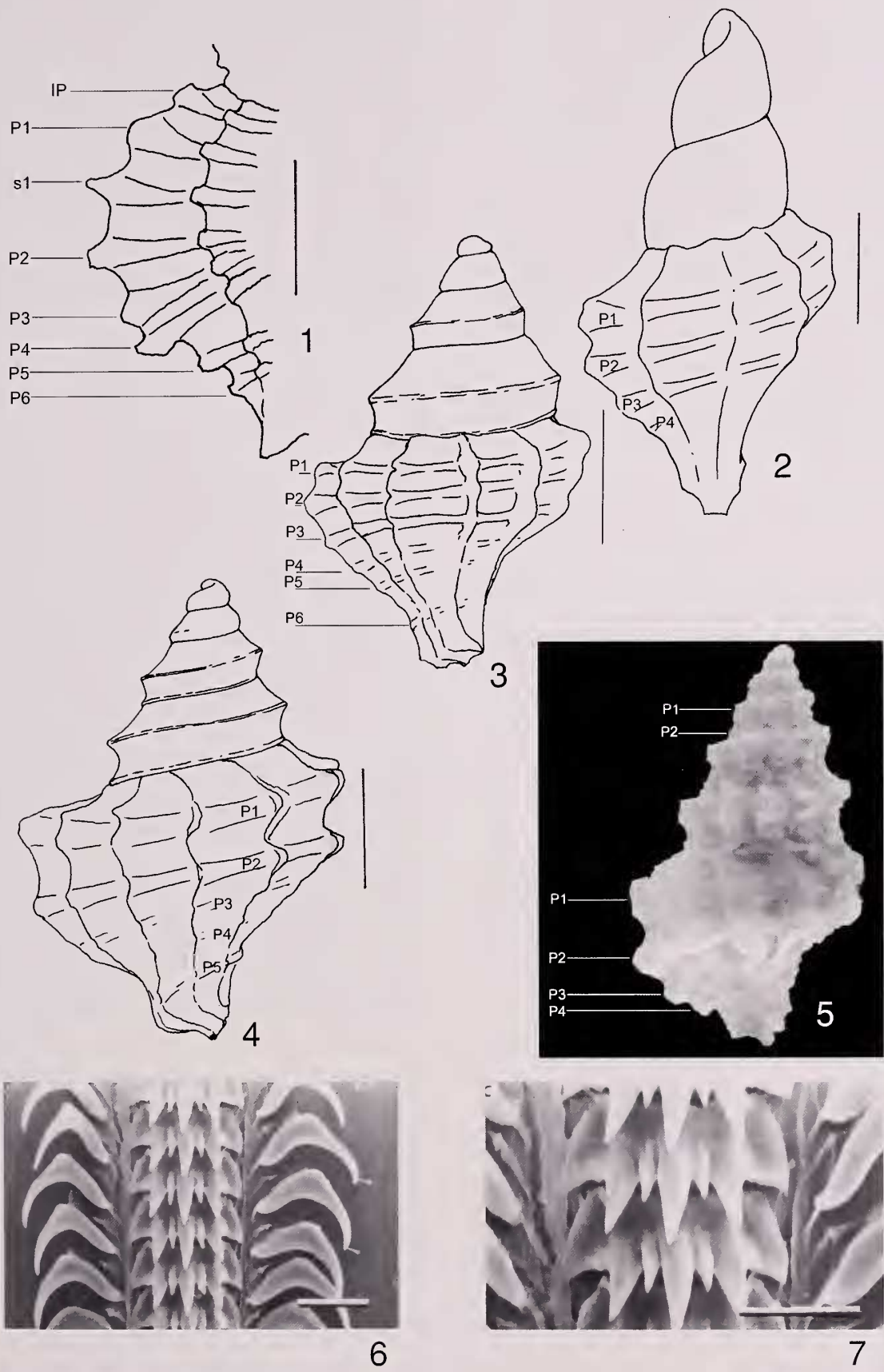
Type material. Tasmania: E of D'Entrecasteaux Channel, 44°2.2' S, 146°50.5' E, 176 m, (holotype AMS C.322414).

Paratypes: **South Australia:** SW of Cape Carnot, 35°15' S, 134°32' E, 150-178 m, (1 AMS C.322386); **New South Wales:** 24 km E of Ballina, 28°49.6' S, 153°51.3' E, 185 m, (1 AMS C.322804) (all dd).

Distribution. New South Wales, South Australia and southern Tasmania

Figures 1-7 (spiral sculpture morphology and radula)

1. *Gemixystus laminatus* (Petterd, 1884); 2. *G. polyphyllius* (Tcnison-Woods, 1879); 3. *G. zebra* n.sp.; 4. *G. protocarinatus* (Laws, 1941); 5. *G. leptos* (Houart, 1995); 6-7. Radula of *G. leptos* (Houart, 1995) (Scale bar: 10 µm)



Description. Shell small, up to 4.1 mm in length (holotype), biconical, lightly built. Spire high with 1.5 protoconch whorls and up to 3 weakly convex teleoconch whorls. Suture impressed. Protoconch large, broad, whorls rounded, smooth; terminal varix unknown (broken or eroded in examined specimens). Axial sculpture of teleoconch whorls consisting of low, narrow, spinose lamellae. First whorl with 7-9 lamellae, second with 9-12, last with 8 or 9. Spiral sculpture of low, broad, rounded cords. First and second whorls with P1-P3 visible, last with P1-P6, (ADP). Small, blunt, broad spines at intersections of axial with spiral sculpture. Shoulder spine (P1) longest. Spines decreasing in length and breadth abapically. Two abapical cords almost similar in size. Aperture broad, roundly ovate. Columellar lip narrow, smooth, rim broken. Outer lip with 3 very weak, low, almost undistinguishable denticles within. Siphonal canal short, 19.5 % of total shell length, weakly dorsally bent at tip, open. White.

Etymology. From the Latin *fimbriatus*: fringed.

Remarks. *Gemixystus fimbriatus* n.sp. differs from the closely similar species *G. rippingalei*, in having a protoconch almost twice as large, higher, more rounded teleoconch whorls, broader and lower spiral cords, broader and shorter spines, and a narrower aperture with a narrower columellar lip and more apparent, narrower denticles within (see Table 1).

***Gemixystus laminatus* (Petterd, 1884)**

Table 1, Figs. 1, 21, 26-29, 56-58

Trophon laminatus Petterd, 1884: 136.

Gemixystus laminatus –Cotton, 1956: pl. 2, fig. 13; Cotton, 1959: 378; May, 1958: 44, pl. 40, fig. 2; Radwin & D'Attilio, 1976: 182, pl. 29, fig. 12; Wilson, 1994: 51, text fig.

Type locality. Tamar Heads, Tasmania.

Type material. Holotype Tasmanian Museum E824.

Material examined. **Queensland:** NE of Cape Moreton, 26°54'-26°57' S, 153°32'-153°35' E, 115-124 m, 1 lv, 4 dd (AMS C.321981); NE of Cape Moreton, 26°55.5' S, 153°33.5' E, 115-124 m, 1 lv, 1 dd (AMS C.321985); off Moreton Bay, 27°31' S, 153°40' E, 75-80 m, 1 dd (AMS C.321915); **New South Wales:** E of Tweed Heads, 28°11'-28°14' S,

153°50' E, 146 m, 1 lv (AMS C.321949); N of Coff's Harbour, 29°39.1' S, 153°41.7' E, 95 m, 1 dd (AMS C.322799); Sydney Harbour, Quarantine Bay, North Head, 33°49' S, 151°17' E, 9-11m, 200 yds offshore, 1 dd; Sydney, Off Cronulla, 34°4' S, 151°30' E, 200 m, 1 lv (AMS C.322866); **Victoria:** between Cape Howe and Lakes Entrance, 37°55' S, 149°0' E, 75-78 m, 2 dd (AMS C.322369); 30 km SW of Cape Everard, 38°3.83' S, 149°8.83' E, 119m, 1 dd (RH); **Tasmania:** Tamar Heads (holotype Tasmanian Museum E824).

Distribution. Southern Queensland, NE of Cape Moreton, to Tamar Heads (Tamar River Entrance), Tasmania, living at 75-200 m.

Description. Shell up to 7.2 mm in length at maturity, lanceolate, frilly. Spire high, with 1.75 protoconch whorls and up to 4.5 convex, occasionally weakly shouldered teleoconch whorls. Suture impressed, partially obscured by small axial lamellae of following whorl.

Protoconch large. First whorl with a strong keel adapically, otherwise smooth; terminal varix delicate, thin, erect, weakly curved.

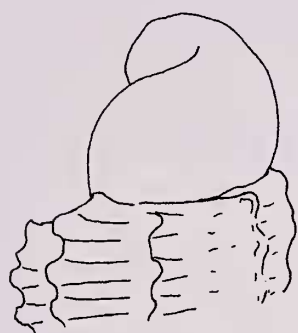
Axial sculpture of high, frilled lamellae: 9 or 10 on first whorl, 12 or 13 on second, 14 or 15 on third, 15-18 on last whorl. Spiral sculpture of high, strong, rounded cords: visible spiral sculpture of first whorl of P1 and P2 or P1, starting s1 after approximately fifth axial lamellae, and P2; second with P1, s1, P2; third with P1, s1, P2 or IP, P1, s1, P2; last whorl with IP, P1, s1, P2-P6. P1, s1 and P2 on last whorl almost similar in size. Small, broad, open spines occur where axial lamellae cross spiral threads. Additional spiral sculpture consisting of narrow, fine striae on shoulder (Fig. 58).

Aperture broad, rounded. Columellar lip narrow, broader abapically, smooth, lip partially erect, adherent at adapical extremity. Anal notch obsolete. Outer lip weakly erect, with 4, weak or strong, elongate denticles within (D1 split, D2, D3). Siphonal canal short, 9-17 % of total shell length. Tan-white or pale tan.

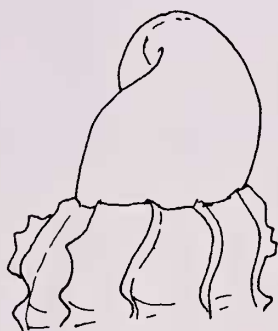
Remarks. For the comparison with *G. rhodanos* n.sp., see under that species and Table 1. All other species of *Gemixystus* differ from *G. laminatus* in having either an acute or a rounded protoconch rather than the strongly keeled protoconch of *G. laminatus*, and a more shouldered last teleoconch whorl. In some species there are other differences, such as more numerous or fewer axial lamellae.

Figures 8-19 (protoconchs); scale bars: 0.5 mm

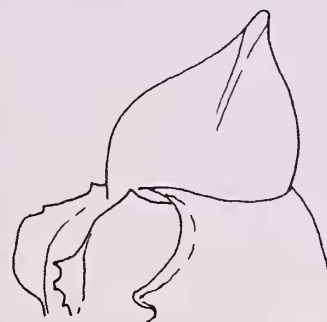
8. *Gemixystus fimbriatus* n.sp.; **9-11.** *G. leptos* (Houart, 1995); **12-13.** *G. polyphyllus* (Tenison-Woods, 1879); **14.** *G. recurvatus* (Verco, 1909); **15.** *G. rippingalei* (Houart, 1998); **16.** *G. hypsellus* (Tate, 1888); **17-18.** *G. stimuleus* (Hedley, 1908); **19.** *Gemixystus* sp. cf. *G. rhodanos* n.sp.



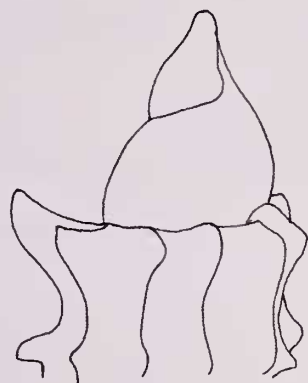
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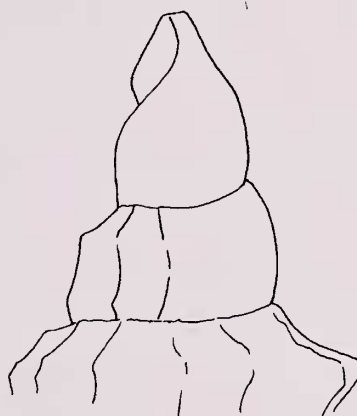
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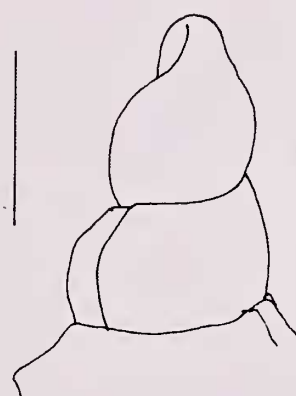
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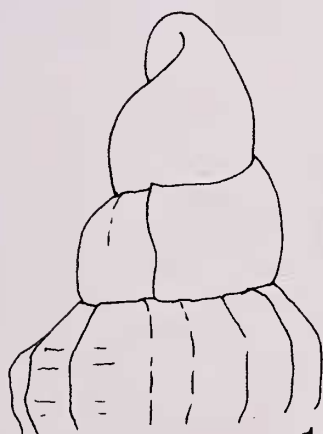
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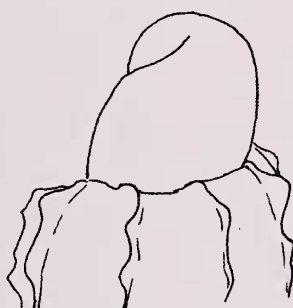
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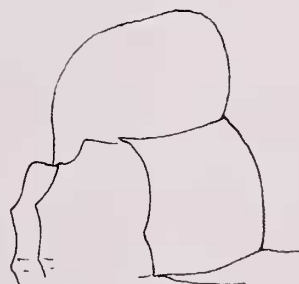
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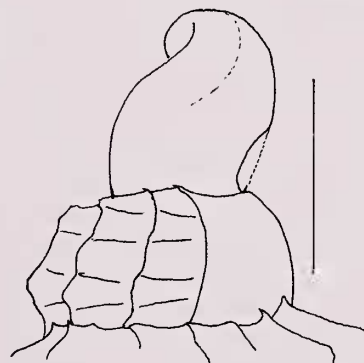
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Gemixystus leptos Houart, 1995

Table 1, Figs. 5-7, 9-11, 22, 30-32, 37

Apixystus leptos Houart, 1995: 490, figs 28-29, 86-89, 134-136.

Apixystus leptos –Houart, 1998: 100, figs 18-19.

Type locality. Coral Sea: MUSORSTOM 5, stn DW 346, 19°40' S, 158°27' E, 245-252 m, lv.

Type material. Holotype MNHN.

Material examined. Coral Sea : 19°40' S, 158°27' E, 245-252 m, lv (holotype and 3 paratypes MNHN). **New Caledonia:** BATHUS 3: stn CP 805, 23°41' S, 168°01' E, 278-310 m, MNHN (1 dd); stn DW 818, 23°43' S, 168°16' E, 394-401 m, MNHN (3 lv & dd); stn DW 824, 23°19' S, 168°00' E, 601-608 m, MNHN (2 dd); SMIB 8: stn DW 169, 23°37' S, 167°42' E, 447-450 m, MNHN (2 dd); stn DW 170-172, 23°40' - 23°41' S, 168°00' - 168° 01' E, 233-290 m, RH (1 lv); stn DW 182-184, 23°18' S, 168°05' E, 305-367 m, MNHN (8 lv & dd), stn DW 190, 23°18' S, 168°05' E, 305-310 m, MNHN (4 lv); NORFOLK 1: stn DW 1692, 24°56' S, 168°21' E, 507-967 m, MNHN (2 dd).

Australia, Queensland: 3 km NE of W side of Gillett Cay, Swain Reefs, 21°42' S, 152°26' E, 64-73 m, 20 dd (AMS C.321889), 5 dd (AMS C.321887); Heron Id, 23°26' S, 151°57' E, 36.5 m, 1 lv (AMS C.321931); Masthead Is, Capricorn Gp, 23°32' S, 151°45' E, 31-37 m, 1 dd (AMS C.21787); 3 km N.E. of N. side of Gillett Bay, Swains Reef, S. Barrier Reef, 64-73 m, 2 dd (AMS C.150077).

Distribution. S Queensland, Australia to Chesterfield Reefs, in 31-252 m; recorded alive in 36.5-252 m.

Description. Shell up to 4.9 mm in length (AMS C150077), spinose, delicate. Spire high with 1.75 protoconch whorls and up to 5 angulate, shouldered, spinose teleoconch whorls. Protoconch acuminate, rounded or keeled, whorls smooth, glossy; terminal varix erect, delicate, thin. Teleoconch suture impressed.

Axial sculpture consisting of sharp, erect lamellae. First whorl with 10 or 11 lamellae, second and third whorls with 11 lamellae, last whorl with 10 or 11 lamellae. Spiral sculpture consisting of weak, rounded cords. First to fourth teleoconch whorls with visible, broadly spaced P1 and P2; last whorl with broadly spaced P1 and P2, followed abapically by narrow, closely spaced, low P3 and P4. Last whorl of a few specimens with s1 between P1 and P2 (AMS C.321889). Short to moderately long, narrow, open spinelets occurring at crossing of axial and spiral sculpture. Spine on P1 longest.

Aperture rounded. Columellar lip flaring, smooth, partially erect, weakly adherent at adapical extremity.

Anal notch obsolete. Outer apertural lip smooth, with 5 strong, narrow, strongly elongate denticles within: D1 (split), D2, D3 (split). Siphonal canal short, 9-11 % of total shell length, narrow, weakly abaxially bent, open, smooth. Translucent milky-white with traces of pale brown on last teleoconch whorl.

Rachidian radular tooth with long central and marginal cusps, and short lateral denticles. Lateral teeth sickle-shaped.

Remarks. *Gemixystus stimuleus* (Hedley, 1907) is smaller, with fewer axial lamellae on the first and second teleoconch whorls; it is also less spinose, with a different morphology of spiral cords (see Table 1). The denticles within the outer apertural lip are smoother, rounded, and not elongate within as in *G. leptos*.

Gemixystus polyphyllius (Tenison-Woods, 1879)

Table 1, Figs. 2, 12-13, 23, 38-43

Trophon polyphyllia Tenison-Woods, 1879: 7, pl. 2, fig. 1.

Apixystus polyphallia –Darragh, 1970: 188.

Type locality. Muddy Creek, near Hamilton, Victoria, NSW (37°44' S, 141°56' E), Lower beds, Balcombian Australian local stage, Middle Miocene.

Type material. Holotype AMS C.170873.

Material examined. NSW: off Botany Bay, 33°41' S, 151°53' E, 366 m, RH (1); Gabo Is, 37°34' S, 149°55' E, 21 m, large boulders covered with sponge and ascidians AMS C.322366 (1); **Victoria:** Balcombe Bay, 38°15' S, 145°02' E, Mornington, Balcombian (Miocene) AMS C.150083 (10), AMS C.70703 (8), RH (1); Mornington, AMS C.150082 (1); S Australia, 40 miles S Cape Wiles, AMS C.32002 (14); **Tasmania:** off Cape Forestier, AMS C.150079 (2); S of South East Cape, 43°42.2' S, 146°18.6' E, 108 m, AMS C.322416 (1); 9.5 miles NE of Tasman Is, 43°12.5' S, 148°13.75' E, 571 m, AMS C.322438 (1); between South East and South West Capes, 43°58.5' S, 146°19.1' E, 168 m, AMS C.322442 (1) (all dd).

Muddy Creek, near Hamilton, 37°44' S, 141° 56' E, lower beds, Miocene (holotype), AMS C.170873.

Distribution. Recent: New South Wales, Victoria, and South Tasmania, depth unknown (no live specimens examined).

Fossil: Victoria, Muddy Creek, Miocene.

Description. Shell up to 5.4+ mm in length at maturity (siphonal canal broken in largest specimen), biconical, frilly. Spire high, acute, with 2-2.25 protoconch whorls and up to 4-4.5 broad, weakly

shouldered teleoconch whorls. Suture impressed, partially obscured by small axial lamellae of following whorl.

Protoconch large, strongly acute, last whorl rounded, smooth, glossy; terminal varix unknown (eroded in all specimens examined).

Axial sculpture of teleoconch whorls consisting of high, narrow, frilly lamellae: 10-12 on first whorl, 12-14 on second, 13-17 on third and fourth. Spiral sculpture of low or high, narrow, rounded cords: visible spiral sculpture of first whorl of P1 and P2 or P1, starting s1 after first or second axial lamellae, and P2; second with P1, s1, P2 or P1 and P2; third with P1, s1, P2; last whorl with IP, P1, s1, P2, s2, P3, P4, P5, P6, ADP or IP, P1, s1, P2, P3, S3, P4, P5. P1, s1 and P2 on last whorl almost similar in size, P4 and P5 small. IP shallow, almost obsolete.

Aperture large, rounded. Columellar lip narrow, smooth, lip adherent. Anal notch obsolete. Outer lip weakly erect, with 4 weak, broad, denticles within (D1 split, D2, D3). Siphonal canal short, 14-18% of total shell length.

Creamy-white or pale tan.

Remarks. The comparison of fossil and Recent material of both taxa leaves no doubt as to their conspecificity. The shells have identical axial and spiral sculpture, and the same apertural and protoconch characters. A young Recent specimen with $\frac{3}{4}$ teleoconch whorl was examined. It clearly start with P1, P2, P3 and small P4 (Fig. 2).



20. Distribution of *Gemixystus fimbriatus* n.sp.



21. Distribution of *Gemixystus laminatus* (Petterd, 1884)



22. Distribution of *Gemixystus leptos* (Houart, 1995)



23. Distribution of *Gemixystus polyphyllus* (Tenison-Woods, 1879)

Gemixystus rhodanos n.sp.

Table 1, Figs. 35, 50-55

Type locality. Australia, New South Wales, 2-3 km E of Malabar, Sydney, 33°59.45' S, 151°16.8' E, 66 m.

Type material. New South Wales: 2.3 km E of Malabar, Sydney, 33°59.45' S, 151°16.8' E, 66 m, 1 dd (holotype AMS C.322835).

Paratypes: **Queensland:** off Maryborough, 25°47' S, 153°33' E, 64 m, 1 lv & 4 dd (AMS C.321945, C.321946); **Queensland:** NE of Cape Moreton, 26°54'-26°57' S, 153°32'-153°35' E, 115-119 m, 1 dd (MNHN ex AMS C.321976); **New South Wales:** 12 km E of Cakora Point, S of Yamba, 29°39.8' S, 153°26.4' E, 55 m, 11 dd (AMS C.322810); **New South Wales:** off Laureton, 31°39' S, 152°48' E, 73 m, 2 dd (coll. Roland Houart); off Sydney, 33°52' S, 151°22.2' E, 79 m, 1 dd (AMS C.322781); **New South Wales:** 2 km E of Long Bay, Sydney, 33°58.83' S, 151°17' E, 66 m, 1 dd (NMNZ M.273108 ex AMS C.322833) **Victoria:** off Cape Everard, Bass Strait, 38°7' S, 149°17' E, 128-146 m, 1 dd (AMS C.322375); **Tasmania:** E of King Id, 40°0' S, 144°38.5' E, 46 m, 1 dd (AMS C.322431).

Other material: Bass Strait, 40 m, 1 dd (TM E7127); **Tasmania:** off Schouten Id, 2 dd (TM 8171/E830).

Distribution. Southern Queensland, New South Wales, eastern Victoria, Bass Strait, Schouten Island, and eastern Tasmania, living at 55-64 m.

Description. Shell up to 5.9 mm in length at maturity (holotype), lanceolate, frilly. Spire high, with 1.5-1.75 protoconch whorls and up to 4 ½ weakly convex teleoconch whorls. Suture adpressed, occasionally obscured by small axial lamellae of following whorl. Protoconch large, whorls weakly or moderately

keeled adapically, otherwise smooth; terminal varix delicate, thin, weakly curved.

Axial sculpture of teleoconch whorls consisting of narrow, frilled lamellae: 12 or 13 on first whorl, 16-18 on second, 22 or 23 on third, 22-24 on fourth and last whorls. Spiral sculpture of rounded cords: visible spiral sculpture of first and second whorls of P1-P3 (P3 just above suture); third with IP, P1-P3; last whorl with IP (occasionally with adis), P1-P6, ADP, MP. Spiral cords approximately similar in size. Additional spiral sculpture consisting of narrow, fine striae and lirae on shoulder and between spiral cords (Fig. 55)

Aperture large, ovate. Columellar lip narrow, smooth. Lip erect, adherent at adapical extremity. Anal notch obsolete. Outer lip broad, with D1-D5 weak, elongate within, rarely low, almost obsolete ID. Siphonal canal short, straight, broadly open, 12-18 % of total shell length. Creamy-white or pale tan.

Etymology. From the Greek *rhodanos*: waving, flickering, relating to its axial sculpture.

Remarks. *Gemixystus rhodanos* n.sp. differs from *G. laminatus* in having a narrower shell with convex whorls instead of shouldered or strongly shouldered teleoconch whorls, most specimens have a less carinate protoconch, in having more numerous, and less frilled axial lamellae (22-24 on last whorl vs 15-18 in *G. laminatus*), a more ovate aperture and different spiral cords morphology (see Table 1) than in *G. laminatus*, and narrow lirae instead of striae.

Gemixystus rhodanos also resembles *Terefundus crispulatus* (Suter, 1908) (Fig. 36), however, as indicated above, *Terefundus* species are characterized by a very small shell (height less than 5 mm), a narrow columellar lip, completely adherent to the shell, a smooth aperture, and a smooth siphonal canal. The genus *Terefundus* is apparently localized in New Zealand.

Figures 24-32**24-25.** *Gemixystus fimbriatus* n.sp.

24. Tasmania, E of D'Entrecasteaux Channel, 44°2.2' S, 146°50.5' E, 176 m, 4.1 mm. Holotype AMS C.322414.

25. Australia, NSW, 24 km E of Ballina. 28°49.6' S, 153°51.3' E, 185 m, 4 mm. Paratype AMS C.322804.

26-29. *Gemixystus laminatus* (Petterd, 1884)

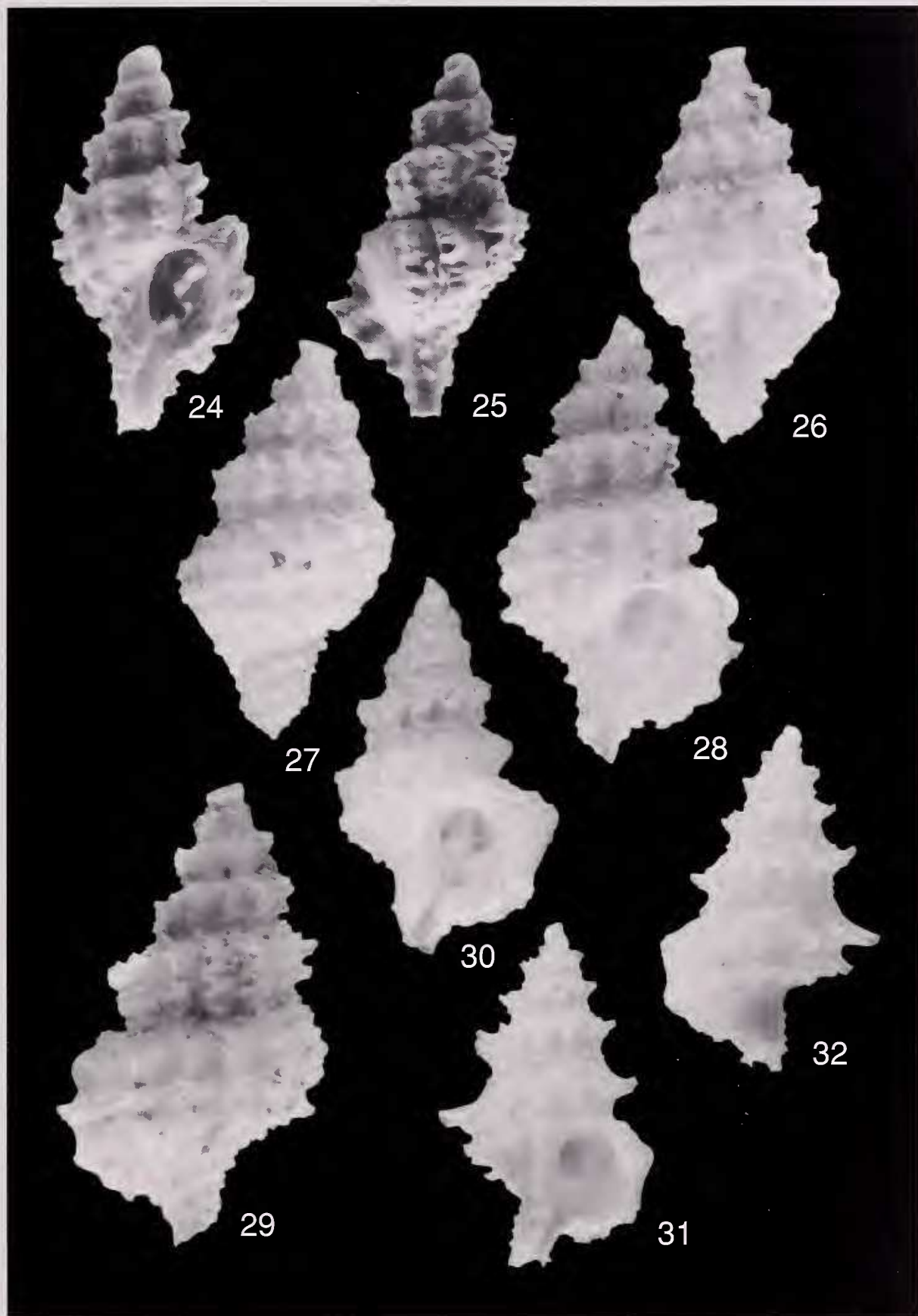
26-27. Tamar Heads, Tasmania, 4.9 mm. Holotype TM E824/8165.

28-29. Australia, NSW, off Cronulla, Sydney, 34.4' S, 151°30' E, 200 m, 6 mm, AMS C.322866.

30-32. *Gemixystus leptos* (Houart, 1995)

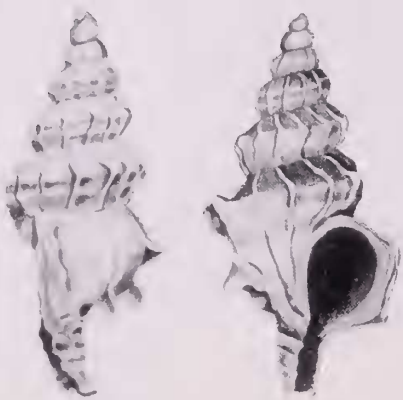
30. Coral Sea, 19°40' S, 158°27' E, 245-252 m, 4.8 mm, holotype MNHN.

31-32. South of New Caledonia, 23°41' S, 168°00'E-168°01', 230-290 m, E, 5.05 mm, MNHN.



***Gemixystus recurvatus* (Verco, 1909)**

Table 1, Figs. 14, 33, 34, 44-47

Trophon recurvatus Verco, 1909: 336, pl. 24, fig. 7, 8.*Benthoxystus recurvatus* –Cotton, 1956: pl. 2, fig. 10; Cotton, 1959: 378; May, 1958: 44, pl. 40, fig. 6; Wilson, 1994: 50, text fig.**Type locality.** Recent, off Beach Port, South Australia, 366 m.**Type material.** Holotype SAM D13484.**Figure 33***Gemixystus recurvatus* (Verco, 1909). Scan taken from original drawing (courtesy Bob Hamilton-Bruce, SAM).**Material examined.** NSW: off Sydney, 384 m, AMS C.150080 (1); **South Australia:** off Beach Port, 366 m, holotype, SAM D13484**Distribution.** New South Wales and South Australia, living at 384 m.**Description.** Shell up to 7 mm in length at maturity, elongate. Spire high, acute, with 2.5 protoconch whorls and up to 4-4.5 broad, weakly angulate, shouldered teleoconch whorls. Suture impressed. Protoconch large, strongly acute, last whorl rounded, smooth, glossy; terminal varix unknown (eroded in specimens examined).

Axial sculpture of teleoconch whorls consisting of moderately high, narrow lamellae: 10 or 11 on first whorl, 12 or 13 on second and third, 9 or 10 on last whorl; intersection of axial lamellae with P1 and P2 giving rise to short, broad, open spines, more obvious on P2. Spiral sculpture of low, narrow, rounded cords, more obvious on last teleoconch whorl: visible spiral sculpture of first whorl consisting of P1 and P2; s1 starting from second whorl; last whorl with P1, (s1), P2, followed abapically by 3 flat, almost indistinguishable additional cords (P3-P5), visible only by the presence of broad, open, low spinelets on axial lamellae; presence of P6 on siphonal canal.

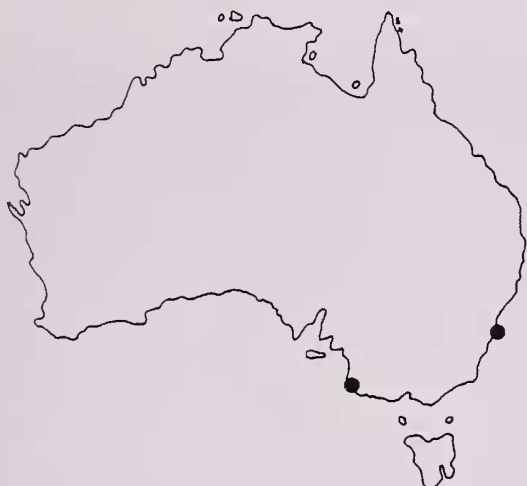
Aperture large, rounded. Columellar lip narrow, smooth, lip adherent. Anal notch obsolete. Outer lip smooth with indistinguishable denticles within. Siphonal canal short, 15 or 16% of total shell length. Creamy white or pale tan.

Remarks. *Gemixystus recurvatus* differs from *G. polyphyllus* in having a larger shell for a same number of teleoconch whorls, in having weakly oblique axial lamellae comparing to the straight, vertical lamellae in *G. polyphyllus* and in having 9 or 10 axial lamellae on the last teleoconch whorl vs 12-17 in *G. polyphyllus*. In *G. recurvatus* s1 is absent or very shallow, almost half the size of P1. When present it is situated closer to P1 than to P2, not centrally between P1 and P2 and more obvious as in *G. polyphyllus*.***Gemixystus rippingalei* (Houart, 1998)**

Tabel 1, Figs. 15, 48, 61-63

Apixystus rippingalei Houart, 1998: 98, figs 14-16, 46.**Type locality.** Queensland, E of Lady Musgrave Id, 23°52.5'-23°51.9' S, 152°42.7'-152°41.7' E, 296 m.**Type material.** Holotype AMS C.313232.**Material examined.** **Queensland:** SE of Swain Reefs, 22°26.27' - 22°20.2' S, 153°17.13' - 152°17.6' E, 187 m, AMS C.321907 (37), AMS C.321900 (1); Capricorn Channel, 23°8.6' S, 152°16.6' E, 155 m, AMS C.321954 (1); E of North West Is, Capricorn Channel, 23°15.2' S, 152°24.1' E, 284 m, AMS C.321963 (1); 24.5 ml E of Lady Musgrave Island, 23°33.7' S, 152°37' E, 339-348 m, AMS C.125294 (3); E of Lady Musgrave Island, 23°52.5' - 23°51.9' S, 152°42.7' - 152°41.7' E, 296 m [holotype AMS C.313232 (dd), 42 paratypes AMS C.313230, 1 paratype BMNH 1996286, 1 paratype MNHN, 1 paratype NM L4346/T1519, 1 paratype NMNZ M.272617, 1 paratype QM MO. 61758, 2 paratypes coll. R. Houart (all dd)]; of Sandy Cape, 24°43.5' - 24°43.8' S, 153°33.4' - 153°33.3' E, 604 m, AMS C.313229, (1); off Maroochydore, 26°41.2' S, 153°38.4' E, 200 m, AMS C.321943, (1); off Cape Moreton, 27°0' S, 153°34' - 153°36' E, 128-183 m, AMS C.150076, (3) (all dd).**Distribution.** Queensland, Australia, in 128-604 m; no living specimens have been examined.**Description.** Shell medium-sized for the genus, up to 4.4 mm in length, spinose, delicate. Spire high with 1.5-1.75 protoconch whorls and up to 4 angulate, shouldered, spinose teleoconch whorls. Suture impressed.

Protoconch large, globose, whorls rounded, smooth; terminal varix shallow, delicate, thin, weakly curved.



34. Distribution of *Gemixystus recurvatus* (Verco, 1909)



35. Distribution of *Gemixystus rhodanos* n.sp.

Axial sculpture of teleoconch whorls consisting of narrow, spinose lamellae: first whorl with 7 or 8 lamellae, second with 10 or 11, third with 12-14, last whorl with 14 lamellae. Spiral sculpture of low, weak, smooth visible cords on first and occasionally on second teleoconch whorl, and of high, rounded cords on other whorls, ending as short spines on crossing of spiral cords and axial lamellae; shoulder spines more conspicuous than others. First and second whorl with P1 and P2, third with P1 and P2 or P1-P3, last whorl with P1-P4 or P1-P6. Spiral cords approximately similar in size.

Aperture moderately small, rounded; columellar lip flaring, smooth, rim partially erect, adherent at adapical extremity; anal notch obsolete. Outer lip undulate, with 4 weak or strong, elongate denticles within (D1-D4). Siphonal canal short to moderately long, 16-23 % of total shell length, open.

Translucent white.

Remarks. *Gemixystus stimuleus* (Hedley, 1907) differs from *G. rippingalei* in having 9 or 10, less frilly axial lamellae on the last teleoconch whorl, the shoulder spines are broader and shorter, and the morphology of the spiral cords is different: 3 low spiral cords (P1-P3) on the last whorl, instead of the 4 strong, high cords (P1-P4) in *G. rippingalei*. The aperture of *G. stimuleus* is ornamented with 2 low, broad denticles within compared to the 4 high, narrow, elongate denticles in *G. rippingalei*. For a comparison with other species see Table 1.

***Gemixystus stimuleus* (Hedley, 1907)**

Table, 1, Figs 17-18, 49, 64-66

Trophon stimuleus Hedley, 1907: 293, pl. 55, fig. 19

Apixystus stimuleus – Cotton, 1956: pl. 2, fig. 9; Cotton, 1959: 378; Radwin & D'Attilio, 1976: 178,

text fig. 118; Kaicher, 1991: card 6085; Wilson, 1994: 50, text fig.; Houart, 1998: 100, fig. 17.

Type locality. New South Wales, Sydney, 22 miles east of Narrabeen, 146 m.

Type material. Holotype AMS C.25797.

Material examined. **Queensland:** off Cape Moreton, 128-183 m, 5 dd (AMS C.150076), NE of Cape Moreton, 26°54'-26°57' S, 153°32'-153°35' E, 115-124 m, 16 dd (AMS C.321981), 1 dd (RH); **New South Wales:** Sydney, 22 miles east of Narrabeen, 146 m (holotype AMS C.25797) (all dd).

Distribution. South Queensland, and Sydney, New South Wales, 115-183 m (shells only).

Description. Shell up to 3.5 mm in length at maturity, biconical. Spire high with 1.5 protoconch whorls, and up to 4 broad, weakly shouldered teleoconch whorls. Suture impressed, partially obscured by small axial lamellae of following whorl. Protoconch large, broadly elongate. Whorls rounded, smooth; terminal varix unknown (eroded in examined specimens).

Axial sculpture of teleoconch whorls consisting of high, strong, webbed lamellae: 9 on first whorl, 12 on second, 15 on third, 11 or 12 on last whorl. Spiral sculpture of rounded cords: visible spiral sculpture of first, second and third whorls of P1-P2; last whorl with P1-P3, decreasing in strength abapically.

Aperture large, broad, rounded. Columellar lip broad, flaring, smooth, lip partially erect, adherent at adapical extremity. Anal notch obsolete. Outer lip broad, with 2 weak, broad, low denticles within. Siphonal canal short, 18-20 % of total shell length, narrow, smooth.

Creamy-white.

Remarks. The small size, the smooth siphonal canal, the few axial lamellae and the different morphology of the spiral cords (see Table 1) separate *D. stimuleus* definitely from any other species of *Gemixystus*.



Figure 36

Terefinchus crispulatus (Suter, 1908). New Zealand, South Island, off Otago Heads, 45°50' S, 170°59' E, 220 m, 3.3 mm. NMNZ M.66835 (courtesy B. A. Marshall, NMNZ).

II. FOSSIL TAXA.

Remarks. Four fossil species of *Gemixystus* are recorded from the Eocene and Miocene in New Zealand. Two Miocene species are reported from the Adelaide (Kent Town) Bore (Eocene) in South Australia.

Gemixystus apipagodus (Ponder, 1972)

Table 2, Figs. 59, 67-71, 75-77

Xymene apipagodus Ponder, 1972: 494, figs 7: 1-3.

Xymene apipagoda – Beu & Maxwell, 1990: 415; Maxwell, 1992: 122, pl. 17a-c.

Type locality. William's Bluff, Lorne, near Oamaru (Late Eocene, Kaiatan).

Other locality. McCullough's Bridge, near Waimate, South Canterbury (Late Eocene, Kaiatan) (paratype TM 5520)

Figures 37-47

37. *Gemixystus leptos* (Houart, 1995), Australia, QLD: Heron Is, GBR. 23°26' S, 151°57' E, 36.5 m, 5.1 mm, AMS C.321931.

38-43. *Gemixystus polyphyllius* (Tenison-Woods, 1879)

38-39. Victoria, Muddy Creek, near Hamilton, 37°44' S, 141°56' E, Miocene, 5.1 mm, holotype AMS C.170873; 40. Victoria, Mornington, Fossil Beach, Balcombe Bay, 38°15' S, 145°02' E, 5.3 mm, coll. R. Houart.

41-42. Tasmania, S of South East Cape. 43°42.2' S, 146°18.6' E. 108 m, 5.4 mm, AMS C.322416.

43. Australia, Victoria, Gabo Is. 37°34' S, 149°55' E. 21 m. Large boulders covered with sponges & ascidians, 5.4 mm, AMS C.322366.

44-47. *Gemixystus recurvatus* (Verco, 1909)

44-45. South Australia, 200 fathoms of Beachport, 6.7 mm, holotype SAM D13484.

46-47. New South Wales, off Sydney, 384 m, 7 mm, AMS C.150080.

Type material. Holotype IGNS, TM 5519 and 3 paratypes TM 5520, 8182, 8183.

Material examined. Holotype and 3 paratypes (IGNS), GS 9481, hillside near former Lorne railway station, North Otago, Waiareka Volcanics (Late Eocene, Kaiatan) (6); GS 11 214, Bridge Point, south side Otago Point, North Otago, Waiareka Volcanics (Late Eocene, Runangan) (2); GS 11185, Slip Point, Clifden Section. Slip Point Siltstone below oyster bed (Middle Miocene, Clifdenian) (1) (with *G. zebra* n. sp.)

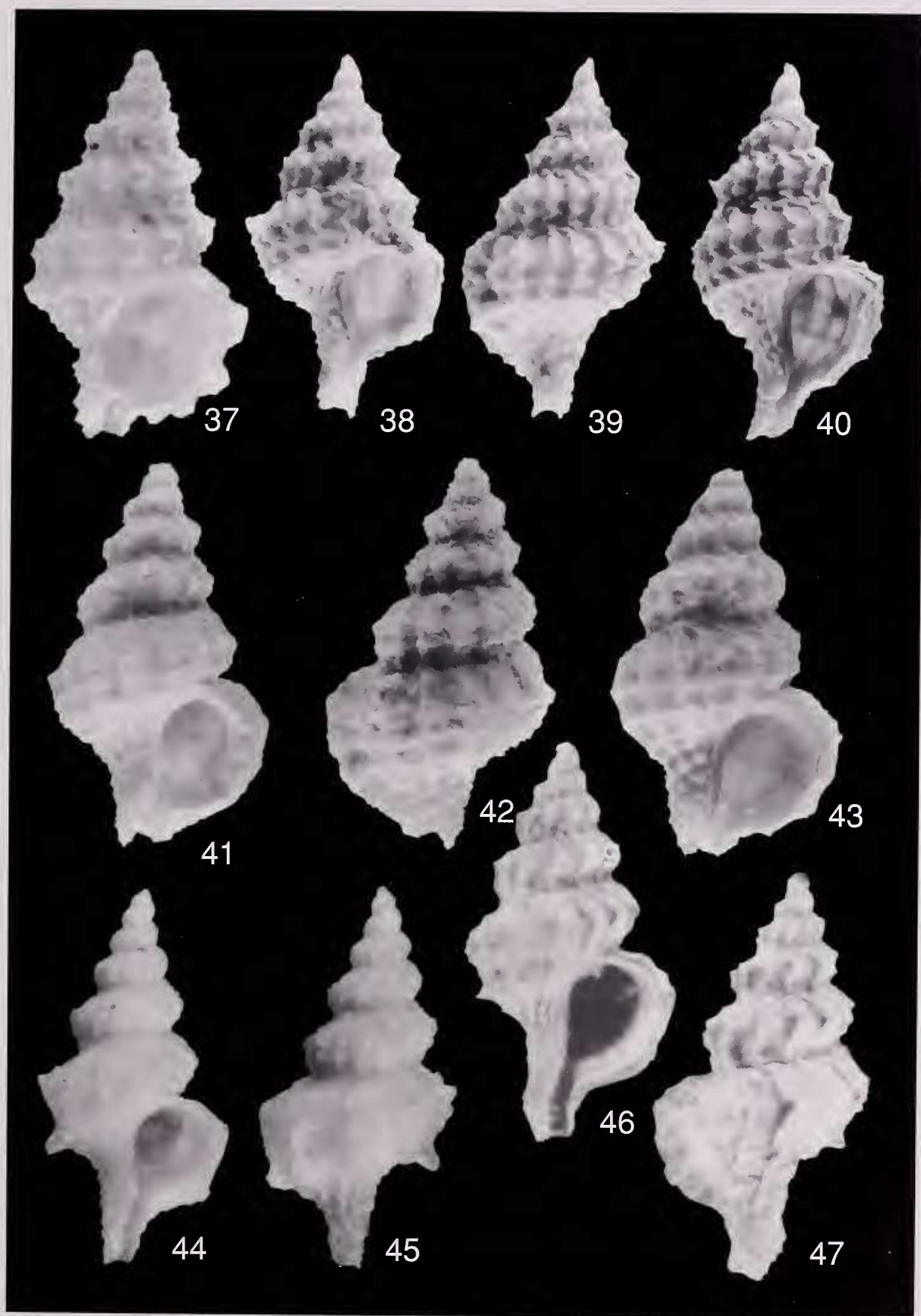
Range. Late Eocene (Kaiatan and Runangan), and Middle Miocene (Clifdenian), New Zealand.

Description. Shell small, up to 5.5 mm in length (holotype), lanceolate, lamellate. Spire high, with 3+ protoconch whorls (broken in all examined specimens), up to 3.75 broad, weakly angulate teleoconch whorls. Suture impressed. Protoconch large, conical, broadly convex; terminal varix low, eroded. Early whorls with numerous, small granules (Fig. 71).

Axial sculpture of teleoconch whorls consisting of strong, low, lamellose varices: 10 on first whorl, 12 on second and third, 10 or 11 on last. Spiral sculpture of strong, rounded, primary cords: P1-P2 on first; second whorl with P1 and P2, starting s1; third with P1, s1, P2; last with P1, s1, P2, P3, P4, P5. P3 and P4 low, narrow.

Aperture broad, rounded. Columellar lip eroded. Anal notch shallow, broad. Outer lip smooth, with 4 broad, low denticles within (D1 split, D2 and D3). Siphonal canal moderately long (damaged in all specimens), open, with 1 narrow, rounded spiral cord (holotype).

Remarks. See Table 2 for comparison with the other species. Specimens from Otago are identical in shell morphology to the type material, however the protoconch is smoother with only a few, small granules on first whorl (Fig. 76). One specimen was separated from lot of *G. zebra* n.sp. (GS 11185). Its time range (Middle Miocene) is quite surprising, however, no difference has been detected in shell sculpture and protoconch morphology (Fig. 77).





48. Distribution of *Gemixystus rippingalei* (Houart, 1998)



49. Distribution of *Gemixystus stimuleus* (Hedley, 1908)

***Gemixystus comes* (Maxwell, 1992)**
Table 2, Figs. 60, 78-82

Xymene comes Maxwell, 1992: 122, pl. 17e-i.

Type locality. McCulloch's Bridge, New Zealand (Eocene, Tahu Member).

Type material. Holotype IGNS, TM 7090.

Material examined. Holotype IGNS, TM 7090 (photograph).

Range. Eocene (Tahu Member), McCulloch's Bridge, New Zealand (type material).

Description. (From Maxwell, 1992 -except spiral cord terminology-). Shell small for genus (height of largest specimen 6.8 mm), ovate-fusiform, spire c. 0.5 total height. Protoconch conical, of about 3 convex whorls, initial whorl bulbous, densely and fine granulose, a fine spiral thread appearing a short distance above suture on 2nd whorl, but disappearing on last whorl; numerous fine granules between spiral thread and suture, and sparse granules on rest of protoconch. Termination of protoconch marked by narrow varix with a prominent adapical sinus.

Teleoconch of 3.5-4 whorls, shouldered at 0.7 whorl height on spire, last whorl with peribasal angulation, contracted over base to moderately long neck. Spiral sculpture commencing at or near beginning of teleoconch as 2 low rounded cords (P1-P2), one marking shoulder angle (P1), the other between it and lower suture (P2), and a third (P3), narrower one largely immersed in lower suture that appears on last whorl at peribasal angulation. Base and neck with 5 additional narrow cords (P4-P6, ADP, MP). Paratype with cord appearing between 2 lower primary cords on 3rd whorl, and another between the 2 upper primary cords (s1) on 4th whorl, quickly becoming as strong as primary cords. Axial sculpture consisting of orthocone to slightly opisthocline, triangular costae with narrow crests, reaching from suture to suture on spire whorls and extending on to base of last whorl; 12-15 costae on penultimate whorl. Crests of costae foliated to form short, open spines at intersections with spiral cords. Aperture ovate-trigonal; columella weakly concave adapically, twisted to left below to form moderately long, open, shallowly notched siphonal canal. Inner lip narrowly callused; outer lip variciform with a shallow gutter at shoulder angulation, and 5 weak denticles below (D1-D5). Fasciole finely lamellose.

Figures 50-58.

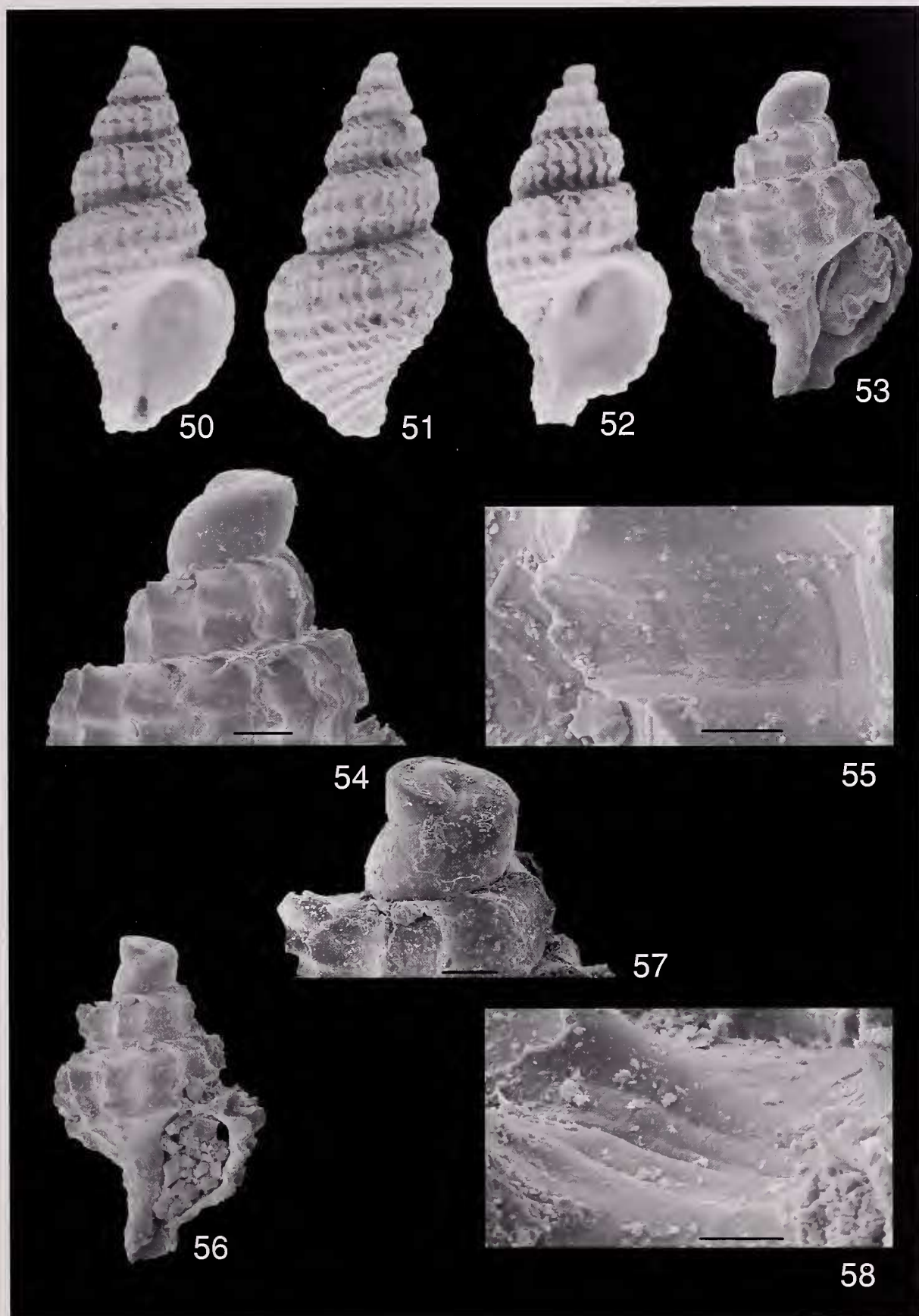
50-55. *Gemixystus rhodanos* n.sp.

50-51. Australia, NSW, 2.3 km E of Malabar, Sydney. 33°59.45' S, 151°16.8' E. 66 m, 5.9 mm, holotype AMS C.322835; 52. Australia, NSW, 12 km E of Cakora Point, S of Yamba. 29°39.8' S, 153°26.4' E. 55 m, 4.4 mm, paratype AMS C.322810.

53-55. Australia, Queensland, off Maryborough, 25°47' S, 153°33' E, 64 m, 2 mm, paratype AMS C.321946.

54. Scale bar: 200 µm; 55. Scale bar: 50 µm.

56-58. *Gemixystus laminatus* (Petterd, 1884), Australia, Queensland, NE of Cape Moreton, 26°55.5' S, 153°33.5' E, 115-124 m, 2.8 mm, AMS C.321985. Scale bars: 57: 200 µm; 58. 50 µm.





59. Distribution of *Gemixystus apipagodus* (Ponder, 1972)

Remarks. This is yet another member of this group of species with small, axially lamellate, shouldered shell. It was originally compared with *Gemixystus apipagodus* (Ponder, 1972) from which it differs in having a shorter, fewer-whorled protoconch with a spiral thread a short distance above the suture on the second whorl and a deeper sinus in the terminal varix. In addition, teleoconch spiral sculpture is more strongly developed in *G. comes* than in *G. apipagodus*.

***Gemixystus hypsellus* (Tate, 1888)**

Table 2, Figs. 16, 72, 83-84

Trophon hypsellus Tate, 1888: 111, pl. 2, fig. 1

Zeatrophon hypsellus –Darragh, 1970: 174.



60. Distribution of *Gemixystus comes* (Maxwell, 1992)

Trophon (Zeatrophon) hypsellus –Ludbrook, 1973: 248, pl. 5, fig. 40.

Type locality. Eocene, Adelaide (Kent Town) Bore, Australia.

Type material. Lectotype SAM T448, here selected from 12 syntypes.

Material examined.

Lectotype and 11 paralectotypes SAM T448.

Range. Eocene, Adelaide (Kent Town) Bore, Australia (type material).

Figures 61-71

61-63. *Gemixystus rippingalei* (Houart, 1998)

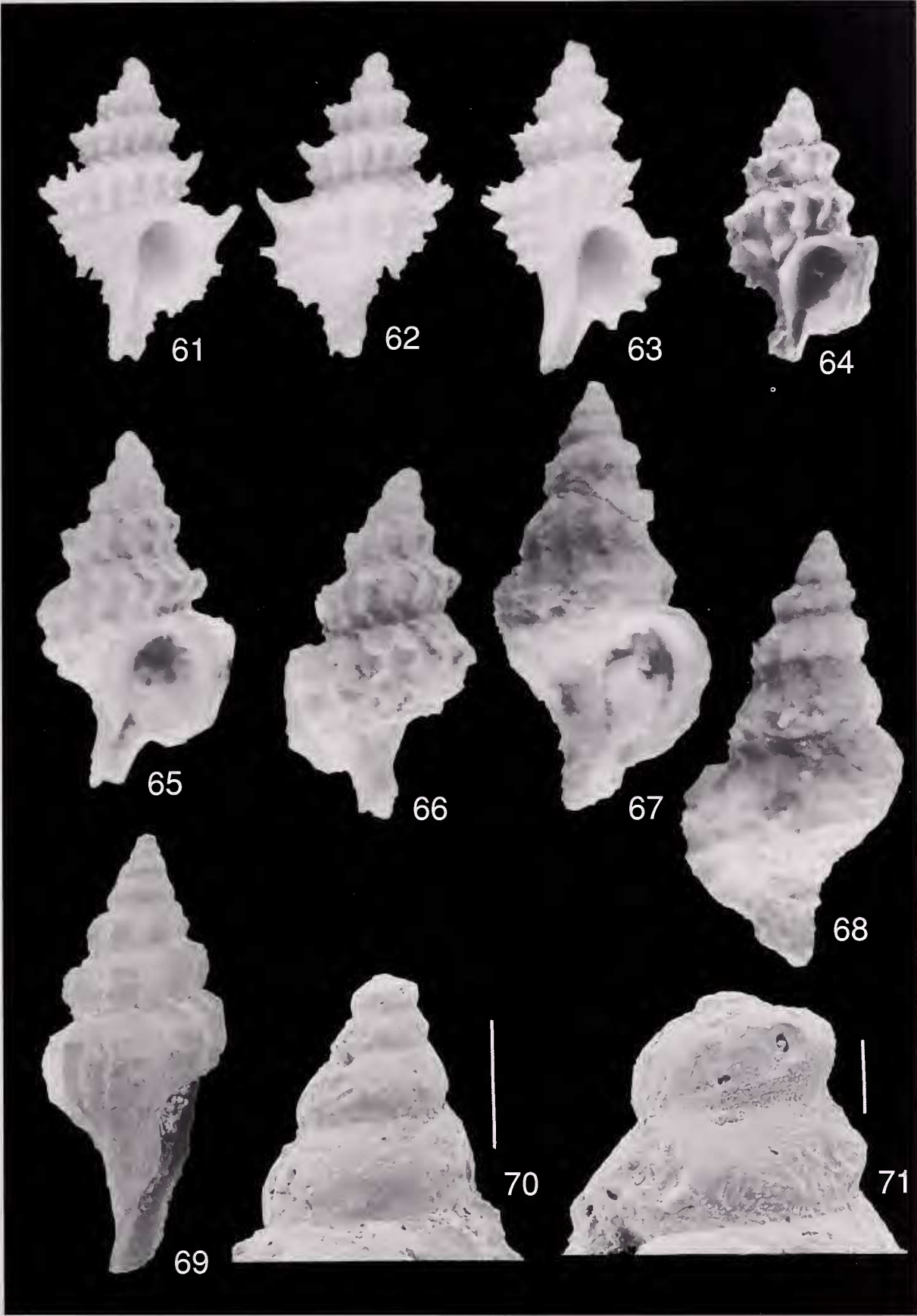
61-62. Australia, Queensland, E. of Lady Musgrave Is, 23°62.5'-23°51.9' S, 152°42.7'-152°41.7' E, 296 m, 4 mm, holotype AMS C.313232; 63 Australia, Queensland, E. of Lady Musgrave Is, 23°62.5'-23°51.9' S, 152°42.7'-152°41.7' E, 296 m, 4.4 mm, paratype AMS C.313232.

64-66. *Gemixystus stimuleus* (Hedley, 1907)

64. Australia, New South Wales, Sydney, 22 miles east of Narrabeen, 146 m, 3.4 mm, holotype AMS C.25797; 65-66. Australia, Queensland, NE of Cape Moreton, 115-124 m, 3.9 mm, coll. R. Houart.

67-71. *Gemixystus apipagodus* (Ponder, 1972)

67-68. New Zealand, William's Bluff, lorne, near Oamaru, (Kaiatan, Upper Eocene), 5.5 mm, holotype IGNS, TM 5519; 69-71. New Zealand, McCulloch's Bridge, probably from Tahu Member (Kaiatan), 5.1 mm, paratype IGNS, TM 5520 (photographs courtesy P. A. Maxwell) (scale bars: 70: 0.5 mm; 71: 100 µm).



Description. Shell small, up to 6.5 mm in length, biconical. Spire high, acute, with 4 protoconch whorls and up to 5 broad, convex, weakly shouldered teleoconch whorls. Suture impressed, partially obscured by small axial lamellae. Protoconch large, whorls rounded, smooth. Last whorl with a narrow keel abapically on a few specimens; terminal varix unknown (eroded).

Axial sculpture of teleoconch whorls consisting of strong, narrow, frilly lamellae. First whorl with 9 or 10 lamellae, second with 10 or 11, third with 10-12, fourth with 12-14, last whorl with 12 lamellae. Spiral sculpture of high, narrow cords. First with P1 and P2, second with P1, P2, starting s1, third and fourth with P1, s1, P2, last whorl with P1, s1, P2, P3-P6 (ADP in a few specimens). P4, and in a few specimens P3 and P4 narrower.

Aperture narrow, rounded, with 4 narrow denticles within: D1 (split), D2, D3.

Siphonal canal short, 16-19 % of total shell length, narrow, open, with 2 spiral cords (3 present in a few specimens) [P5-P6, (ADP)]. Abapical cord lower.

Remarks. See Table 2 for comparison with the other species. As noted by Ludbrook (1973: 247), Tate's types come from depths between 45 and 66.4 m, stratigraphically low in the Aldingan. Tate (1882) stated these beds to be Miocene age, but in subsequent papers (Tate, 1890; Tate & Dennant, 1896) correctly placed them in the Eocene.

Ludbrook (pl. 25, fig. 40) illustrate the specimen figured by Tate as being the holotype, however, Tate never designated it as such. Ludbrook's use of the term "holotype" does not constitute a valid lectotype designation (ICZN, Art. 74.5.).

Gemixystus icosiphyllus (Tate, 1888)

Table 2, Figs. 72, 86-87

Trophon icosiphyllus Tate, 1888: 110, pl. 2, fig. 3

Type locality. Eocene, Adelaide (Kent Town) Bore, Australia.

Material examined. Lectotype SAM T442, here selected from 4 syntypes.

Range. Eocene, Adelaide (Kent Town) Bore, Australia (type material).

Description. Shell small, up to 7.6 mm in length (paralectotype), lanceolate, frilly. Spire high with 1.5 protoconch whorls and 4 weakly convex, teleoconch whorls. Suture impressed, partially obscured by small axial lamellae of following whorl. Protoconch large, whorls rounded. Terminal varix unknown (eroded).

Axial sculpture of teleoconch whorls consisting of narrow, frilled lamellae. First whorl with 10 or 11 lamellae, second with 14, third unknown (specimens glued on a cardboard), last whorl with 20 lamellae. Spiral sculpture of narrow, rounded cords. First 2/3 parts of first whorl smooth, starting spiral sculpture on last 1/3 part, visible part of second whorl with 3 or 4 low cords (IP, P1-P3), third whorl with IP and 4 cords (IP, P1-P4) on visible convex part of whorl, last whorl with IP on shoulder, and 11 cords, almost similar in size.

Aperture large, broad, rounded. Columellar lip partially broken, narrow, apparently smooth; anal notch obsolete. Outer lip broad, weakly denticulate inside. Siphonal canal short (partially broken), straight, open.



72. Distribution of *Gemixystus hypsellus* (Tate, 1888) and *G. icosiphyllus* (Tate, 1888).



73. Distribution of *Gemixystus protocarيناتus* (Laws, 1941)

Remarks. The fact that the shells are glued on a cardboard, the particular start of the spiral sculpture at the last third part of first teleoconch whorl, the numerous spiral cords on the convex part of the last whorl, and the absence of young specimens which prevents the study of the ontogenesis, made it impossible to determinate the precise position and the terminology to use to designate the spiral cords on the last teleoconch whorl.

There is an obvious relationship between *G. icosiphyllus* and *G. rhodanos* n.sp. (Figs. 50-52 and 86-87), however, *G. rhodanos* has broader and fewer spiral cords, a shorter siphonal canal and a weakly or moderately keeled protoconch.

As for *G. hypsellus*, Ludbrook (pl. 25, fig. 51) illustrate the specimen figured by Tate as being the holotype, however, Tate never designated it as such. Ludbrook's use of the term "holotype" does not constitute a valid lectotype designation (ICZN, Art. 74.5.).

***Gemixystus protocarينات* (Laws, 1941)**

Table 2, Figs. 4, 73-74, 88-90

Xymenella protocarينات Laws, 1941: 148, fig. 45

Xymene protocarينات –Beu & Maxwell, 1990: 415.

Type locality. Pakaurangi Point, Kaipara Harbour, Northland, northern North Island, Early Miocene (Otaian).

Type material. Not found (formerly in IGNS).

Material examined. GS 13105, Waioha shellbeds, thin shelly bands and lenses in fine sand/Siltstone at head of beach and in shore platform, 50-200 m east of mouth of Waioha Stream, north shore of Parengarenga Harbour, grid ref. N02/071450 (1975 metric), coll. A.G. Beu & P.A. Maxwell, February 1970 & later recollections, (21), Early Miocene (Otaian); west side, mouth of Tahuna Channel, north shore Parengarenga Harbour, Northland. Tahuna Pebbly Mudstone early Miocene (Otaian), P.A. Maxwell coll. (5); Hollands Point, Pakaurangi Point, Kaipara Harbour, Waiteroa Member, Pakaurangi Formation, Early Miocene (Otaian), P.A. Maxwell coll. (1); Taita Stream, c. 400 m upstream from Oraora Stream, Waimamaku, Early Miocene (Otaian), P.A. Maxwell coll. (4).

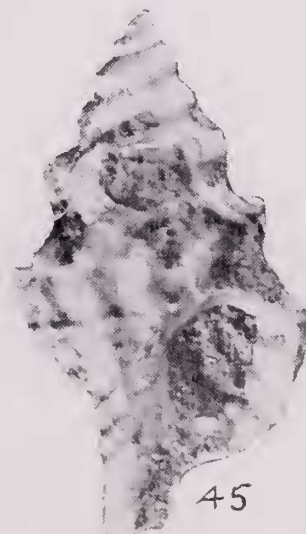
Range. Early Miocene (Otaian).

Description. Shell small, up to 4.1 mm and more (protoconch broken in largest specimen), biconical, heavy, spinose. Spire high with 4.5 - 4.75 protoconch whorls and up to 3.75 broad, strongly shouldered, weakly spinose teleoconch whorls. Suture impressed. Protoconch large, conical, first and second whorls rounded, starting duplicate keel from third whorl;

protoconch I with few, small granules on first whorl (Fig. 90); protoconch II with minute oblique axial lamellae on first whorl in well preserved specimens; terminal varix erect, strongly end of third and following whorls with strong, narrow, duplicate keel; terminal varix heavy, erect, strongly curved, of sinusigera type.

Axial sculpture of teleoconch whorls consisting of low, broad lamellae: first whorl with 9-11 lamellae, second and third with 11 or 12, last whorl with 9 or 10. Spiral sculpture of 5 rounded cords (P1-P5). First to last whorl with 2 rounded, strong adapical primary cords (P1 and P2), P2 narrower than P1; third cord (P3) low, narrower than P1 and P2; fourth cord almost obsolete, followed by P5. Early whorls of adult specimens with visible P1 and P2. Crossing of axial lamellae with P1 and P2 giving rise to short, broadly open spines. P1 weakly duplicate in a few specimens.

Aperture large, broad, rounded. Columellar lip narrow, smooth. Outer lip with 4 strong, narrow denticles within: D1 (split), D2 and D3. Siphonal canal short, 9-11 % of total shell length, straight, open.



74. *Gemixystus protocarينات* (Laws, 1941)
(Original illustration from Laws, 1941).

Remarks. *A. protocarينات* was confused with *A. zebra* n.sp. by Ponder (1972). See under *A. zebra* and Table 2.

***Gemixystus zebra* n.sp.**

Table 2, Figs. 3, 85, 91-95

Xymene protocarينات –Ponder, 1972: 492 (in part), figs 2: 15, 7: 4 (NOT *Xymenella protocarينات* Laws, 1941).

Type locality. New Zealand, "Beach Road", coast 0.4-1.6 km south of Awamoa Creek, North Otago. Mount Harris Formation (Altonian).

Type material. New Zealand: "Beach Road", coast 400-1600 m south of Awamoa Creek, North Otago. Mount Harris Formation (Altonian), holotype IGNS TM 8280 (ex P.A. Maxwell coll.).

Paratypes: GS 12 600, road cutting, Otueka Hill, road to Mitimiti, Hokianga district, Northland, Early Miocene (Otaian) (1); GS 12 601, Pinehill Stream, Waimamaku, Hokianga district, c 200 m upstream from road (Otaian) (9); P.A. Maxwell coll., thin shellbeds, 50-300 m W of Waioha Stream, Parengarenga Hbr; Waioha Shell beds, Parengarenga Formation (Otaian) (3); P.A. Maxwell coll., Taita Stream, c. 400 m upstream from Oraora Stream, Waimamaku, Northland (Otaian) (with *G. protocarinatus*) (1); GS 10 365 (8), R. Houart (2), Long Beach Shellbed, Long Beach, Clifden Section, Early Miocene (Altonian); P.A. Maxwell coll., Clifden Section, right bank, Waiau River, southland, Slip Point Siltstone, 3-5 m above base, Middle Miocene (Clifdenian) (20); P.A. Maxwell coll., Slip Point, Clifden Section, right bank Waiau River, Southland, Slip Point Siltstone, below oyster bed (Clifdenian) (2); GS 11 185, Slip Point, Clifden Section, Slip Point Siltstone below oyster bed (Clifdenian) (13); GS 11 186, top of Slip Point Siltstone, above oyster bed, Slip Point, Clifden Section, Middle Miocene (Lillburnian) (1); GS, "Oyster bed", S side Park Bluff, Clifden Section, above Cucullaea Point Shellbed, Park Bluff Formation (Lillburnian) (49).

Range. Early Miocene (Otaian) to Middle Miocene (Lillburnian).

Description. Shell small, up to 4.6 mm in length (holotype), triangular. Spire high, acute, with 4.75 protoconch whorls and up to 3.75 teleoconch whorls. Suture impressed. Protoconch large, conical, acute, with duplicate keel on penultimate and last whorls; protoconch I with numerous, small granules (Fig. 94); protoconch II with minute oblique axial lamellae in well preserved specimens; terminal varix erect, strongly curved, of sinusigera type.

Axial sculpture of teleoconch whorls consisting of low, broad lamellae, with broad varix erratically placed on last whorl in a few specimens: 10-12 lamellae on first whorl, 10-13 on third, 14-15 on third, 9 or 10 on last. Spiral sculpture of 5 primary cords on convex part of whorl: P1-P5, with P1 and P2 visible on first whorl of most specimens; other whorls with three visible cords (P1-P3) IP starting from penultimate or last whorl in a few specimens. Last whorl with (IP), P1-P6, ADP, (MP). P2 and P3 usually stronger, weakly higher than P1, P4 and P5 usually weaker. P3-P5 closer to each other than P1-P3.

Aperture moderately broad, rounded. Columellar lip narrow, smooth. Outer lip with 4, occasionally 5, strong denticles within: D1-D4. D4 broader than other denticles or split. Siphonal canal short, straight, open, 12-17 % of total shell length.

Etymology. From the Latin *zebra*; name for the striped equine of Africa, relating to the axial sculpture of the protoconch.

Remarks. *Gemixystus zebra* n.sp. was confused with *G. protocarinatus* by Ponder (1972: 492). However, it differs in having a different spiral sculpture morphology, *G. protocarinatus* having 4 primary spiral cord on the convex part of teleoconch whorls instead of 5 in *G. zebra*. Moreover, in *G. zebra* P2 and P3 are stronger and higher than P1 in most specimens whereas P1 is broader than P2 in *G. protocarinatus*. The third cord (P3) in *G. zebra* is the strongest in most specimens while it is much lower than P1 and P2 in *G. protocarinatus* (Figs. 3-4). *G. zebra* is also more weakly shouldered with shorter, low, broadly open spines at the intersection of axial sculpture and primary spiral cords. The protoconch of *G. zebra* is ornamented with oblique axial lamellae (observed in the holotype and a few well preserved specimens). This particular character has been also observed in *G. protocarinatus*, but only on the early whorls of the protoconch and less obvious. Other species of *Gemixystus* differ markedly and do not need to be compared here. See also Table 2.

Figures 75-84

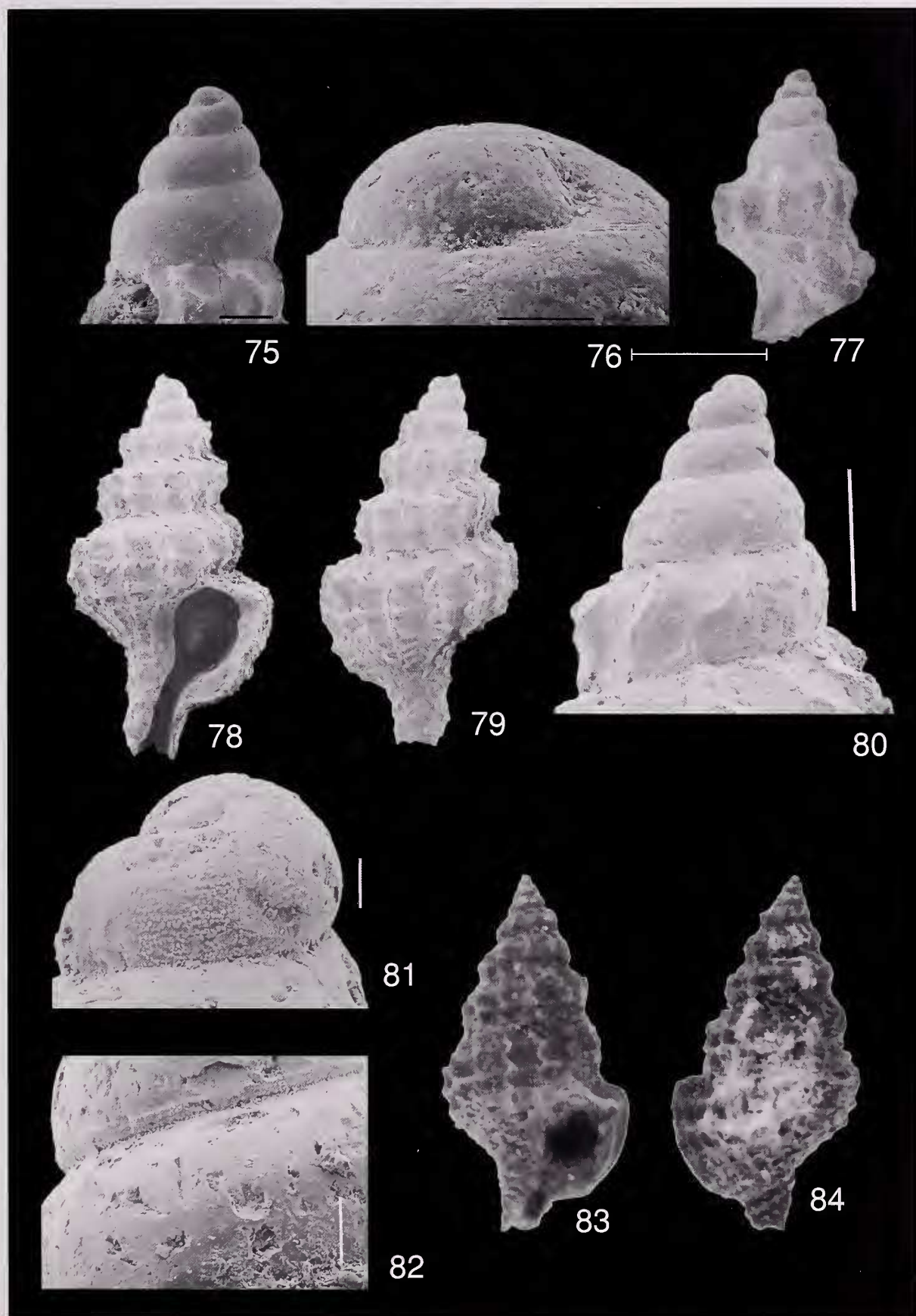
75-77. *Gemixystus apipagodus* (Ponder, 1972), New Zealand, Slip Point, Clifden Section, Slip Point Siltstone below oyster bed (Clifdenian), 2.1 mm, IGNS 11185 (scale bars: 76: 200 µm; 76: 50 µm).

78-82. *Gemixystus comes* (Maxwell, 1992) (photographs courtesy P. A. Maxwell).

78-79. New Zealand, Tahu member, McCulloch's Bridge (Kaiatan), 5.1 mm, holotype TM 7090 (GS 9508).

80-82. Paratype TM 7091 (scale bars: 80: 0.5 mm; 81 & 82: 100 µm).

83-84. *Gemixystus hypsellus* (Tate, 1888). Australia, Adelaide (Kent Town) Bore, Eocene, 5.9 mm, Lectotype SAM T448.





85. Geographical distribution of *Gemixystus zebra* n.sp.

Gemixystus sp.
Fig. 96

Material examined. GS 11 463, New Zealand, White Stream, Eyre River, North Canterbury, below chalk quarry. *Asterocyclina* bed at top of exposed section. View Hill Volcanics, Early Eocene (Mangaorapan) (5).

Remarks. This is probably the earliest record of the genus. Unfortunately the specimens are poorly preserved, with only the protoconch whorls and first whorl preserved. The closest known species is currently *G. apipagodus* but in this Early Eocene species s1 starts on the first whorl (somewhere after the third lamellae) while in *G. apipagodus* s1 starts on the second whorl. The spiral cords and the axial lamellae of *Gemixystus* sp. are broader and the protoconch is lower while also consisting of 3+ rounded, smooth whorls. A more detailed comparison is not possible at this time.

Gemixystus sp. cf. *G. rhodanos*
Fig. 19

Material examined. New Zealand, "Beach Road", coast 400-1600 m south of Awamoa Creek, North Otago. Mount Harris Formation, Early Miocene (Altonian), P.A. Maxwell coll. (1).

Remarks. This shell suggests a close relationship with *Gemixystus* in having a similar teleoconch sculpture. However, the protoconch is different from that of any known fossil species, being large, paucispiral, broad and weakly shouldered as in *G. rhodanos* n.sp. In fact, the shell seems close to both *G. rhodanos* and *G. laminatus*, with six spiral cords on the last teleoconch whorl (P1-P6), and ADP. However the shell is a juvenile of 4 mm high with only 1.75 teleoconch whorls and is slightly damaged (protoconch and last whorl) so that a more detailed comparison is not possible. It is here tentatively classified in *Gemixystus*.

Figures 86-96

86-87. *Gemixystus icosiphyllus* (Tate, 1888). Australia, Adelaide (Kent Town) Bore, Eocene, 7.5 mm, lectotype SAM T442.

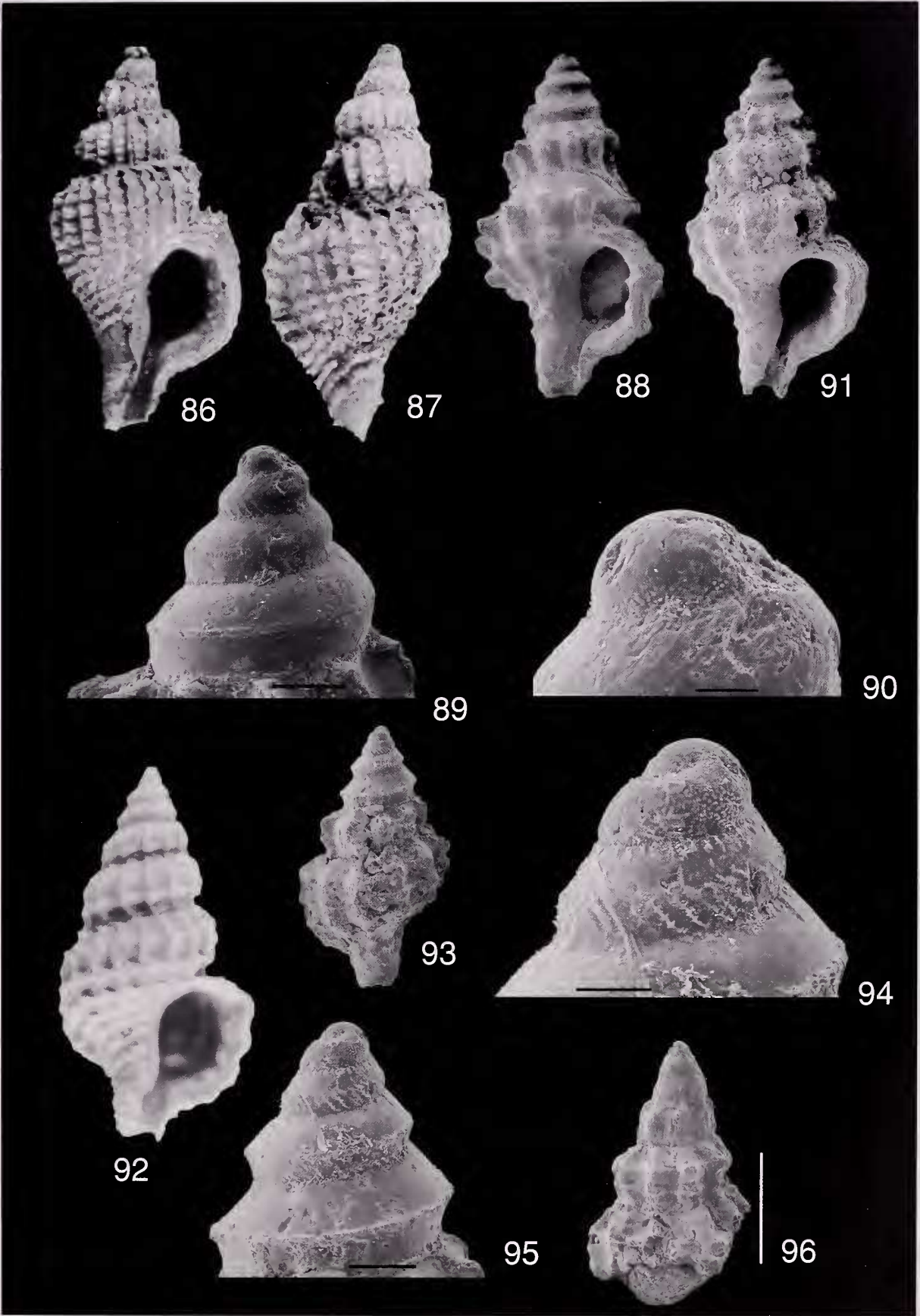
88-90. *Gemixystus protocarinatus* (Laws, 1841)

88. New Zealand, west side, mouth of Tahuna Channel, north shore Parengarenga Harbour, Northland. Tahuna Pebbly Mudstone (Otaian), 3.1 mm, Maxwell collection; 89-90. New Zealand, Waioha shellbeds, thin shelly bands and lenses in fine sand/Siltstone at head of beach and in shore platform, 50-200 m east of mouth of Waioha Stream, north shore of Parengarenga Harbour, GS 13105 (scale bars: 89: 200 μ m; 90: 50 μ m).

91-95. *Gemixystus zebra* n.sp.

91, 93-95. New Zealand, "Oyster bed", S side Park Bluff, Clifden Section, above Cucullaea Point Shellbed, Park Bluff Formation (Lillburnian), paratype GS; 91: 3.5 mm; 93: 2.5 mm; 94: scale bar 100 μ m; 95: scale bar 200 μ m; 92. New Zealand, Beach Road", coast 400-1600 m south of Awamoa Creek, North Otago, Mount Harris Formation (Altonian). Holotype IGNS, TM 8280, 4.6 mm.

96. *Gemixystus* sp. New Zealand, White Stream, Eyre River, North Canterbury, below chalk quarry. *Asterocyclina* bed at top of exposed section. View Hill Volcanics, Early Eocene (Mangaorapan), GS 11 463, scale bar: 1 mm.



Characters	<i>G. finbriatus</i>	<i>G. laurinus</i>	<i>G. leptos</i>	<i>G. polyphyllus</i>	<i>G. rhodatus</i>	<i>G. rippingalei</i>	<i>G. recurvatus</i>	<i>G. stimulans</i>
Maximum length	4.1 mm	7.2 mm	4.9 mm	7 mm	5.9 mm	4.4 mm	7 mm	3.5 mm
Protoconch	Protoconch large, broad, whorls rounded, smooth; terminal varix unknown.	Protoconch large. First whorl with a strong keel adapically, otherwise smooth; terminal varix delicate, thin, erect, weakly curved.	Protoconch acuminate, rounded or keeled, whorls smooth, glossy; terminal varix erect, delicate, thin.	Protoconch large, strongly acute, last whorl rounded, smooth, glossy; terminal varix unknown.	Protoconch large, whorls weakly or moderately keeled adapically, otherwise smooth; terminal varix delicate, thin, weakly curved.	Protoconch large, globose, whorls rounded, smooth; terminal varix shallow, delicate, thin, weakly curved.	Protoconch large, strongly acute, last whorl rounded, smooth, glossy; terminal varix unknown.	Protoconch large, broadly elongate. Whorls rounded, smooth; terminal varix unknown.
Number and size of spiral cords of last whorl including siphonal canal	P1-P6, occasionally ADP. Small, blunt, broad spines emerging from crossing of axial with spiral sculpture.	IP, P1, s1, P2, P6. P1, s1 and P2 on last whorl almost similar in size. Small, broad, open spines occur where axial lamellae cross spiral threads.	Broadly spaced P1 and P2, followed abapically by narrow, closely spaced, low P3 and P4. In a few specimens s1 between P1 and P2. Short to moderately long, narrow, open spinelets occurring at crossing of axial and spiral sculpture. Spine on P1 longest.	IP, P1, s1, P2, s2, P3, P4, P5, P6, ADP or IP, P1, s1, P2, P3, S3, P4, P5. P1, s1 and P2 on last whorl almost similar in size, P4 and P5 small. IP shallow, almost obsolete.	IP (occasionally with adis), P1-P6, ADP, MP. Spiral cords approximately similar in size.	P1-P4 or P1-P6. Spiral cords approximately similar in size. Presence of short spines on crossing of spiral cords and axial lamellae; shoulder spines more conspicuous.	P1, (s1), P2, followed abapically by 3 flat, almost indistinguishable additional cords (P3-P5), visible only by the presence of broad, open, low spinelets on axial lamellae; presence of P6 on siphonal canal.	P1-P3, decreasing in strength abapically.
Number of axial lamellae of last whorl	8 or 9	15-18	10 or 11	13-17	22-24	14	9 or 10	11 or 12
Denticles of the inner side of the aperture	Outer apertural lip smooth, with 5 strong, narrow, strongly elongate denticles within: D1 (split), D2, D3 (split).	Outer lip weakly erect, with 4, weak or strong, elongate denticles within (D1 split, D2, D3).	Outer apertural lip smooth, with 5 strong, narrow, strongly elongate denticles within: D1 (split), D2, D3 (split).	Outer lip weakly erect, with 4 weak, broad, denticles within (D1 split, D2, D3).	Outer lip broad, with D1-D5 weak, elongate within, rarely low, almost obsolete ID.	Outer lip undulate, with 4 weak or strong, elongate denticles within (D1-D4).	Outer lip broad, with 2 weak, broad, low denticles within.	Outer lip broad, with 2 weak, broad, low denticles within.
Distribution	New South Wales, South Australia and southern Tasmania.	South Queensland, NE of Cape Moreton, to Tamar Heads (Tamar River Entrance), Tasmania, living at 75-200 m.	South Queensland, Australia to Chesterfields Reefs, in 31-252 m; recorded alive in 36.5-252 m.	Recent : off Sydney, New South Wales, Victoria, and S Tasmania, depth unknown (no live specimens examined). Fossil : Victoria, near Hamilton, Miocene.	South Queensland, New South Wales, East Victoria, Bass Strait, Sehouten Island, and eastern Tasmania, living at 55-64 m.	Queensland, Australia, in 128-604 m, no living specimens have been examined.	New South Wales and South Australia, living at 384 m.	South Queensland, and Sydney, New South Wales, depth unknown.

Table 1. Comparison of Recent species of *Gemixystus*

Characters	<i>G. apapigodus</i>	<i>G. comes</i>	<i>G. hypsellus</i>	<i>G. icosiphyllus</i>	<i>G. protocarinatus</i>	<i>G. zebra</i>
Maximum length	5.5 mm	6.8 mm	6.5 mm	7.6 mm	4.1 mm	4.6 mm
Protoconch	3+ whorls. Large, conical, broadly convex; terminal varix shallow, eroded. Early whorls with numerous, small granules	3 whorls. Conical. Presence of a fine spiral thread appearing a short distance above suture on 2nd whorl. Numerous fine granules, dense on first whorl, sparsely distributed elsewhere; terminal varix narrow with prominent adapical sinus.	4 whorls. Large, whorls rounded, smooth. Last whorl with a narrow keel abapically in a few specimens; terminal varix unknown (eroded).	1.5 whorls. Large, whorls rounded.	4 ½ - 4 ¾. Large, conical, first and second whorl rounded, starting duplicate keel from third whorl; end of third and following whorls with strong, narrow duplicate keel. Protoconch I with few, small granules on first whorl; protoconch II with minute oblique axial lamellae on first whorl in well preserved specimens; terminal varix heavy, erect, strongly curved.	4 ¾ whorls. Large, conical, acute, with duplicate keel abapically on penultimate and last whorls. Protoconch I with numerous, small granules; protoconch II with minute oblique axial lamellae in well preserved specimens; terminal varix erect, strongly curved, of sinusigera type; terminal varix erect, strongly curved, of sinusigera type.
Number and size of spiral cords of last whorl including siphonal canal	P1, s1, P2-P5. P3 and P4 low, narrow.	P1, s1, P2, P3, P4, s4, P5, P6, ADP, MP.	P1, s1, P2-P6 (ADP in a few specimens). P4 narrower, P3 and P4 in a few specimens.	IP + 11 cords. The numerous spiral cords on the convex part of the last whorl, and the absence of young specimens which prevent the study of the ontogenesis, made it impossible to determinate the position and the terminology to use to designate the spiral cords.	P1-P5: first to last whorl with 2 rounded, strong adapical primary cords (P1 and P2), P2 narrower than P1; third cord (P3) low, narrower than P1 and P2; fourth cord almost obsolete. P1 duplicate in a few specimens.	(IP), P1-P6, ADP, (MP). P2 and P3 usually stronger, weakly higher than P1, P4 and P5 usually weaker. P3-P5 closer to each other than P1-P3.
Number of axial lamellae of last whorl	10 or 11	12-15	12	20	9 or 10	9 or 10
Denticles of the inner side of the aperture	Outer lip smooth, with 4 broad, low denticles within (D1 split, D2 and D3).	Outer lip with 4 low denticles within: D1 (broadest and highest), D2, D3, D4.	4 narrow denticles within: D1 (split), D2, D3.	Weakly denticulate inside. Terminology unknown.	Outer lip with 4 strong, narrow denticles within: D1 (split), D2 and D3.	Outer lip with 4 (occasionally 5) strong denticles within: D1-D4. D4 broader than other denticles or split.
Range	New Zealand: Kaiatan and Runangan (Upper Eocene) and probably Clifdenian (Middle Miocene).	New Zealand: Tahu Member, McCulloch's Bridge (Eocene).	Australia: Adelaide (Kent Town) Bore (Eocene) (type material).	Australia: Adelaide (Kent Town) Bore (Eocene) (type material).	New Zealand: Otaian (Early Miocene) to Waiaun (late Middle Miocene).	New Zealand: Otaian (Early Miocene) to Lillburnian (Middle Miocene).

Table 2. Comparison of fossil species of *Gemixystus*

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